demonstrated during the war that scientific men who from motives of patriotism accepted a low scale of salary for their services in Government Departments were accorded an equally modest official status.

The ultimate basis on which an adequate recognition of the importance of the scientific technical expert must rest will be the estimation in which science and scientific research are held by the great mass of intelligent men and women. It must be realised, in the first place, that a training in science on the right lines and under the right men will be as efficient in broadening the outlook on the world and stimulating the imagination of the student as a detailed study of the vicissitudes of ancient wars or the eccentricities of Greek and Latin irregular verbs. It must also be recognised that no course of science can be considered complete unless it has included a session at least spent in scientific research, humble though it may be and directed by more experienced workers. But it must be genuine research, not merely a "heuristic" imitation of the real thing.

The more science graduates who have learnt to understand what research means there are scattered about the country—in factories, in counting-houses, in Government offices, in educational establishments of every kind, and, most important of all, in municipalities and legislative bodies—the wider will be the recognition of the value of science.

Unfortunately, scientific studies are seriously handicapped in the competition for university students by the fact that the fees are, as a rule, distinctly higher than those for arts. There is, therefore, a strong pecuniary inducement for parents to select an arts rather than a science curriculum for their children. Such a handicap is obviously opposed to the national interest, and should not be allowed to continue.

In view of the urgent reasons for associating research with higher scientific education, it is to be regretted that the general tendency of Government policy should be to divorce industrial research from the universities and to place it in the hands of associations of commercial firms. The discoveries that open up new lines of development in great manufacturing industries are arrived at by processes essentially similar to those that lead to advances in pure science, and if we are to get the best results it will be by the co-operation of the vigorous university life which has sprung up in recent years at so many centres in busy industrial districts with the commercial enterprise in its vicinity.

Finally, if we are to secure to science its full weight in the councils and policy of the country, we must not confine our propaganda to the "governing" or upper classes, or to the ranks of professional workers, or to those engaged in commercial pursuits, but we must develop by all the means in our power a love of science in the great army of the manual operatives, whom it would seem that in a not distant future we shall, willingly or unwillingly, have to acknowledge as our masters. With their increased leisure there should be no difficulty in enlisting a large contingent of men and women who will be interested in science, either for its own sake or for its value in enabling them to understand the meaning of the work in which they are engaged. Some of them will in all probability definitely embrace a scientific career, and in this they should receive every assistance and encouragement, while others will render no less service as amateurs and as missionaries of science among their fellows. Already, I am told, a great deal is being done in this direction in connection with University College, Nottingham, and no doubt much is being accomplished on similar lines at the Midland and Northern universities. At present the operations of the Workers' Educational Association are largely confined to the somewhat restricted domains of constitutional law and history and political ecenomy, but a few years may see a great development of more stimulating and attractive studies in the broad realms of science.

March 31. John W. Evans.

The Secondary Spectrum of Hydrogen.

The recent investigation by Dr. Merton of the effect of an admixture of helium on the intensity distribution in the hydrogen spectrum appears to have given a very strong clue towards the elucidation of that spectrum. On the photographs taken by Dr. Merton (reproduced in part in Proc. Roy. Soc., October, 1919) the spectra appear completely different in the cases of pure hydrogen and of hydrogen mixed with helium. Many lines, in the first case quite strong, are totally absent in the second; others remain practically unaltered in intensity; while a third set appears in the second case, though practically or completely invisible in the first. Such results seem, at first sight, to point to the existence of at least three classes of lines which are mutually independent, one class being unaffected by helium and the others affected in opposite senses.

A somewhat exhaustive investigation which I have made recently in regard to these photographs, kindly lent to me by Dr. Merton, and the previously published tables of the spectrum has convinced me, however, that this interpretation is not the correct one. It was known already that the secondary spectrum of hydrogen contained two sets of lines, one showing, and the other not showing, the Zeeman effect. A third and doubtful set were abnormal in regard to the Zeeman effect. Dufour examined many of the strong lines in the spectrum, and, although his investigation needs still to be extended much further, a considerable amount of exact knowledge of individual lines is available.

Fulcher also had previously investigated the low-potential discharge in hydrogen, and isolated two band spectra peculiar to this discharge, which spectra we may call the Fulcher bands. They differ from more ordinary bands in their large component separations, and their most important part is in each case a set of triplets which recur towards the red end. Although they do not readily fit the Deslandres type of formula, I have been able to establish a mathematical relationship between the two bands, from which it appears that they must be considered jointly as one band. In addition to the triplets there are many associated sets of single lines, which Fulcher considered, on experimental grounds, to belong to the same band system.

Dr. Merton's results have made a valuable contribution which enables us to isolate these Fulcher bands completely from the rest of the spectrum.

The conclusions at which I have already arrived may be summarised as follows:—

The secondary spectrum of hydrogen consists of a set of band spectra—how far divided into sets which are mutually independent in the mathematical sense is uncertain, but at least partially so divided—together with a superposed spectrum of single lines. The band lines are those which show no Zeeman effect, and the lines of the superposed spectrum all show the Zeeman effect. This general statement still requires considerable experimental work to establish its complete truth, but the evidence so far available is sufficient to leave little doubt in the matter.

Dr. Merton's spectra, taken in the presence of helium, preserve what I have called the superposed

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spectrum without much change of intensity, and it is undoubtedly due, on all grounds, to a different atomic or molecular mechanism from that producing the bands. This superposed spectrum exhibits very pronounced "constant frequency difference" effects, and there is good reason to believe that sets of series spectra of the ordinary Rydberg type may be included in it and form the basis of the constant differences of wave-number. The series spectra of hydrogen would then be no longer confined to the Balmer series.

On the photographs the behaviour of the "band" lines is peculiar. The "head"—a word not used in the ordinary sense, but as denoting the strongest line of the band and the one most remote from the red end—is preserved in intensity in helium, or even enhanced, while all the other members disappear. A line in pure hydrogen may be weak, but if it is really a band-head in this sense, it is prominent in the presence of helium—the head is not always the strongest line in a band in pure hydrogen. This consideration is the real clue to the interpretation of the photographs, and it has been found possible to isolate the entire Fulcher band, which is of a remarkable structure and accounts for the great majority of lines between H_α and H_β, in part of which region the previous measures have been very incomplete and misleading. Other strong bands of similar character occur in other regions, and it is already clear that the complete analysis involves only a few such individual bands showing no Zeeman effect, together with a line spectrum showing Zeeman effect, and apparently capable of arrangement in constant frequency differences.

These investigations will shortly be published, but in view of the importance this spectrum has now assumed in relation to atomic structure a preliminary statement of its nature appears to be desirable.

J. W. Nicholson.

University of London, King's College,
March 21.

International Council for Fishery Investigations.

A perusal of the programme of the International Council for Fishery Investigations, as outlined in Nature of March 18, substantiates the criticisms published in 1902 and 1903, as well as later. In the interests of the fisheries and of the public in these critical times it is imperative to direct attention once more to the position. In the original programme of about twenty years ago the Council were to discover whether the yield of the sea-fisheries was increasing or diminishing, and especially to demonstrate the impoverishment of the sea (as if the myriads of ova on the fishmongers' slabs every year afforded no lesson); to show to what extent fishing-grounds could be depleted without danger; to point out what fishing apparatus was destructive; to investigate the small fish grounds; to make discoveries of practical importance to the fisheries; to publish annual results; and finally to produce data (even within two years) on which British and foreign legislation could be based.

Now, after sixteen to twenty years' labour and a great expenditure of public money (for salaries went on during the war), it is found that the impoverishment plea is dropped, along with most of the heads just mentioned as requiring solution. The new scheme, to take the heads in the order in which they appear (see Nature, March 18, p. 84), includes an inquiry into the result of "the most gigantic scientific experiment ever made in respect to the closure of areas." It is unlikely that the fisheries of the North Sea will be to any extent altered by the partial closure caused through the operations of the Grand Fleet. The ways of Nature are not so simple. Then comes the old phantom of the diminishing plaice and the protection of the race by a size-limit, an impracticable idea so far as the security of the younger plaice goes. The larval, post-larval, and smaller forms are in prodigious numbers, and are safe. Nor is confidence in the Council increased when the ten years' work of the Scottish Fishery Board's ship, *Garland*, in the closed areas is now regarded as ineffective, and the subject not sufficiently studied! In other words, the deliberate conclusions of the Scottish Board, so resolutely upheld, and on which the closure of the Moray Firth and other areas was based, are null and void. That is one way of escaping from an untenable position. The Council may well spare the "intensive study" of the plaice so far as the prosperity of the British fisheries is concerned, and so with further experiments on plaice-marking and drift-bottles, as well as on the food of the young. Nothing important on these heads can result from continued expenditure. The lemon-dab requires little attention, for, like other doomed fishes of the kind, it has re-asserted itself. There is no urgent need for studies on the herring, though this was supposed to be one of the diminishing fishes not long ago. Yet a word must be said in favour of the Danish exploration of the North Atlantic, where, and in the Mediterranean, Dr. Johs. Schmidt carried out such excellent work on the life-history of the eel.

The hydrographical and plankton work of the Council has hitherto borne little fruit in the matter of the fisheries, and it is unlikely that, after twenty years' probation, more will be accomplished.

The revival of the bathybius-myth in the form of the supposed "vitamines" in sea-water may give point to a sentence, thus: "The searcher for economic results in fisheries must have the basal theory and knowledge . . . as the foundation on which he has to build," but that is *vox et praeterea nihil* unless a practical acquaintance with the whole details of the life-history of the sea-fishes is possessed by him. Mere collation of statistics without such a check is of little avail in the complex problem of the sea-fisheries, which, however, now as heretofore, hold their own against the combined attacks of their own kind, as well as of man, seals, whales, birds, and invertebrates. Marine animals have been kept in pure sea water without food for years, yet the suggested application of the "vitamine" theory to the oyster and mussel does not offer much scope. The best *parcs* for fattening the oysters have much more than "vitamines," and even the *ejectamenta*, etc., of the mussels in the estuaries will by and by raise mounds several feet above sea-level.

Four French names are given as members of the Council, but they are less familiar than those of Fabre-Domergue, Canu, Cligny, Raveret-Wattel, and Pellegrin. Again, one British name is conspicuous by its absence, viz. that of Dr. A. T. Masterman, a highly trained and talented fisheries expert. It is to be hoped that no interference by officialdom, as dealt with in the leading article in Nature of March 25, is connected with his retirement. Those who remember the case of Sir Joseph Hooker and Mr. Ayrton have reason to be jealous of the official status of experienced men of science in carrying out their researches for the benefit of the country.

Finally, there can be little doubt that Britain would be better and more economically served by competent workers in its marine laboratories, where, moreover, young zoologists could acquire a competent knowledge of the marine fisheries.

W. C. McIntosh.

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